PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.:	10/021,727
Filing Date:	December 12, 2001
Applicant:	Keskula et al.
Group Art Unit:	1746
Examiner:	Monique M. Wills
Title:	AIR DISTRIBUTION METHOD AND CONTROLLER FOR A FUEL CELL SYSTEM
Attorney Docket:	GP-301184 (8540G-000084)

DECLARATION UNDER 37 C.F.R. 1.131

The undersigned hereby declare that:

1. We are joint inventors who made application for a patent on December 12, 2001 which is the subject of the present application.

2. We completed our invention in the United States prior to May 4, 2001, the filing date of United States Patent Application Publication 2002/0164515.

3. We conceived of our invention in the United States as evidence by the diagram and written description attached as Exhibit A which is a portion of a record of invention. This written description was made prior to May 4, 2001.

4. Our invention was reduced to practice in the form of an air subsystem for the gasoline Gen 2 fuel cell system as represented by the mechanization schematic depicted in the drawing attached as Exhibit B. The schematic was prepared and the air subsystem depicted therein was constructed prior to May 4, 2001.

5. Our invention was successfully tested in the United States as evidenced by the data graphs attached as Exhibit C which are a portion of a report summarizing the development and testing of the air subsystem referenced in paragraph 4 above. The testing was conducted and the report was prepared prior to May 4, 2001.

6. Each of the dates redacted from he attached Exhibits A-C is prior to May 4, 2001.

Each of the undersigned hereby declare that the statements made herein of his own knowledge are true and that the statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 the United States Code, and that such willful false statement may jeopardize the validity of the application, and any patent issuing thereon, or any patent to which this declaration is directed.

Donald H. Kelskula — Date: 27 JAN 05

Bruce J. Clingerman — Date: 27 JAN 05

Swaminathan Gopalswamy — Date: 03 Feb 05

Shankar Akella — Date: 31 JAN 05

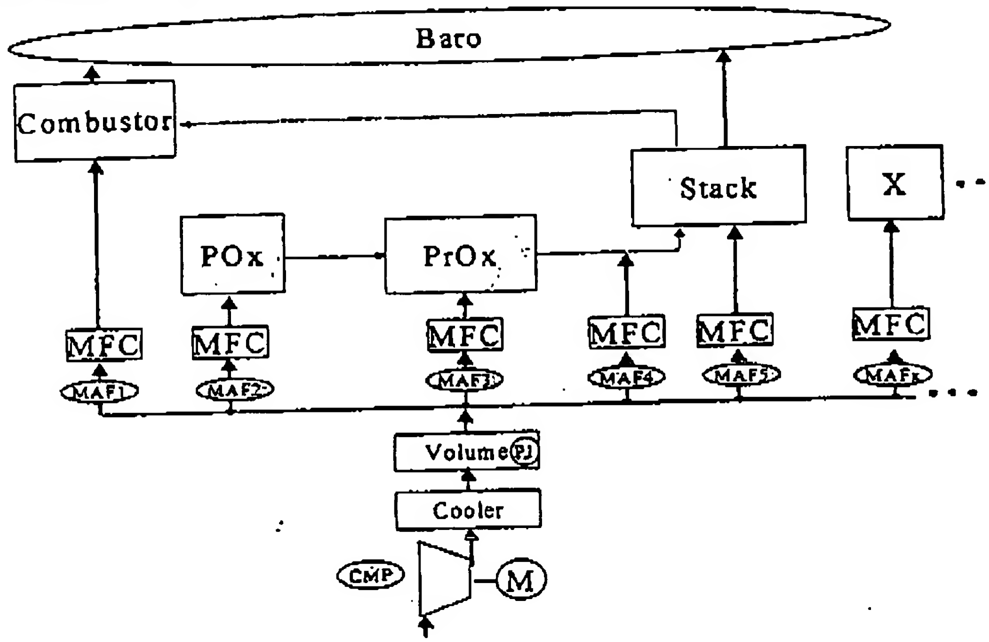
EXHIBIT A

Answer question 9 thoroughly.

9. Describe the invention in sufficient detail so that its nature, operation and usefulness can be understood. (Attach drawings, diagrams and further description, when necessary. Additional guidelines are listed below.)

See the attached report "Comparison of Pressure Based Fuel Cell Airflow System Control vs. Mass Flow Based Fuel Cell Airflow System Control" for simulation data and more analytical discussion...

Referring to the diagram below.



The invention addresses a fuel cell system which comprises of several subsystems that are dependent on each other, primarily, a compressor or compressors, the fuel cell stack, fuel processor, combustor, anode air bleed, etc.. The air is typically supplied by a compressor or multiple compressors, and distributed to the subsystems by various means (such as directly from a compressor, or through a valve or mass flow controller, etc...).

For steady state operation, the airflow requirements of the different branches can simply be summed, and the compressor commanded to that airflow together (e.g. $MAF_{CMP} = MAF1+MAF2+MAF3+MAF4+MAF5+MAFx\ldots$), which is then fairly easily controlled with a traditional controls approach (e.g. PID). However, as transient capability becomes required for the system, the interaction of the subsystems becomes a significant challenge due to the coupling of the subsystems. The simplistic approach mentioned above will no longer be viable in a transient environment.

This invention is an approach that effectively controls each of the subsystems independently.

In this invention, the compressor is controlled as a function of it's downstream pressure (P1), typically in a volume or manifold (this volume can be an existing manifold or plumbing, or added as required), while the downstream subsystems it is supplying independently control their own mass air flow. The only interface required is for the subsystems downstream of the compressor to supply the compressor pressure control loop with any minimum pressure that they might require.

The primary impact of this approach lies in the fact that the downstream subsystem airflow dynamics are directly proportional to the volume or manifold pressure P1, and not the compressor output airflow. The compressor output airflow only indirectly affects the subsystem dynamics by affecting the rate of change of pressure in the manifold volume. Therefore, by appropriate choice of the manifold volume and the desired values for the pressure in the manifold, much tighter transient control of the subsystem airflow becomes possible. Further, this approach de-couples the interactions between the subsystems to a larger extent, thereby enabling the more efficient distributed development of the control system for the downstream subsystems.